

Charge  
Engineering Design Review  
LQX – Inner Triplet Quadrupole Cryoassembly

Background:

FNAL is responsible for the cryostats for the IR Interaction Region Quadrupole systems. The FNAL work scope includes:

- Design, development and fabrication of the cryostats.
- Construction of a full-scale model heat exchanger.
- R&D on support structures.
- Construction of a cryostat for the full-scale prototype quadrupole.
- Assembly of U.S.- and Japanese-built quadrupoles (MQXB and MQXA respectively) together with CERN-supplied correction coils into the cryostats to produce complete LQX cryoassemblies for all four interaction regions.
- Design and fabrication of the intermediate beam absorbers.

Planned Design Reviews:

An Engineering Design Review (EDR) is to be conducted when most of the R&D is complete and the engineering design has been finalized. For a system to pass the EDR, it must be demonstrated that all of the technical and engineering challenges have been adequately addressed.

This EDR follows a Conceptual Design Review (CDR) that was held on 3 December 1998 and an Interim Design Review that was held on 13 March 2000. The reports, including action items, have been issued for both of these reviews.

This EDR will be followed by a Production Readiness Review (PRR). The PRR occurs after final proof-of-design is complete, i.e., after prototypes are delivered and tested successfully, etc. It must occur before the final production of the deliverables for the LHC. The PRR must include a strategy for fabrication or procurement, quality assurance, and a component test plan. The PRR is planned for July 2001.

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Design Team:

The design is represented by:

- J. Kerby, FNAL Project Manager
- T. Nicol, FNAL Cryostat Lead Engineer
- T. Page, FNAL
- M. Lamm, FNAL

Design Review Committee:

The design review committee members are as follows:

- Phil Pfund, FNAL, Chairman
- Jim Strait, FNAL
- Tom Taylor, CERN
- Ranko Ostojic, CERN
- Gilbert Trinquart, CERN
- Rob van Weelderen, CERN
- Ralph Trant, CERN
- Lloyd Williams, CERN
- Jean-Philippe Tock, CERN
- Blazej Skoczen
- Philippe Sacre
- Ian Collins, CERN
- Tom Peterson, FNAL
- Erich Willen, BNL
- Steve Plate, BNL
- Jon Zbasnik, LBNL

Scope of the Review:

The EDR will cover the following items in particular:

- Final designs of:
  - the LMQXB cold mass, which consists of two MQXB quadrupoles together with an MCBX dipole corrector;
  - the LMQXA cold mass, which consists of an MQXA quadrupole together with an MCBX dipole corrector;
  - and the LMQXB cold mass, which consists of an MQXA quadrupole together with an MCBXA dipole plus multipole corrector package and an MQSXA skew quadrupole plus multipole corrector package.
- Final design of the LQXA, LQXB and LQXC cryostats including testing to support design decisions.
- Functional Specification and Interface Specification documents that are planned.
- Special equipment for transportation, installation, and alignment in the tunnel at CERN.
- Design concepts explicitly not covered during the CDR: support of MQXA (KEK cold mass) and MQXB (FNAL cold mass), 1.9 K heat exchanger and connection of Q2a and Q2b cold masses.

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The review will not explicitly cover the design and testing of the MQX IR high gradient quadrupoles. The MQXB was covered by a separate EDR conducted on 16 March 2000 and the MQXA is the responsibility of KEK. The review will however cover the interfaces of the cryostat to both types of magnet cold masses, corrector magnets, and interconnect between adjacent IR quadrupoles.

The design review committee has the usual freedom to investigate other areas of the cryostat design that present a risk to the successful completion of the project, installation, and operation in the LHC.

Date of the Review Committee Meeting:

The review is scheduled for 12 March 2001 at CERN. It is anticipated to take one day.

Results of the Review:

The EDR review is expected to result in a clear statement by the Project Manager approving, disapproving, or limiting the completion of the design of the LMQX cold mass assemblies and the LQX cryostat units. In the case of limited approval, the Project Manager will specify design hold points requiring additional approval or review along with the requirements for moving beyond those hold points. The review committee is expected to make their recommendations with this objective in mind.

This review is a Level-3 project milestone, previously scheduled for completion 1 November 2000. The current forecast date for completion is 15 March 2001. The review will be complete with the issuing of a report summarizing the technical designs reviewed, committee recommendations, and action items.

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Schedule for the Review:

EDR Schedule – LQX Cryostat

17 Feb 2001	Contents of preview package selected by the FNAL project Manager and approved by the US LHC Project Manager.
26 Feb 2001	Preview package and draft agenda posted on a FNAL web site. Reviewers will be notified of the URL and given a list of material posted. Reviewers will be given subsequent notification when additional documents are posted or existing documents modified.
5 Mar 2001	Reviewers provide preliminary comments to the Chairman. The comments are intended to ensure that issues of specific interest to the reviewers will be adequately addressed during the review meeting. The comments are based on the material provided in the preview package and on each reviewer's previous knowledge of the project and technology.
9 Mar 2001	Agenda revised by the Chairman based on preliminary comments from reviewers and discussions with the FNAL Project Manager.
12 Mar 2001	Design Review meeting conducted.
23 Mar 2001	Draft report of the review sent to reviewers by the Chairman.
2 Apr 2001	Reviewer return comments on the draft report to the Chairman.
15 Apr 2001	Final report of review approved by the US LHC Project Manager and issued by the Chairman.

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Agenda for the Review Meeting:

**EDR Agenda – LQX Cryoassemblies**  
**12 March 2001**  
**CERN**

- 09:00      ***Design Review Committee Planning Session*** – P. Pfund
- Confirmation of Agenda and Schedule
  - Remarks on Wrap-up and Closure of EDR
- 09:10      ***Overview*** – J. Kerby
- Requirements (*LQX Functional Specification, MQX EDR*)
  - CDR & IDR (*results and status of action items*)
- 09:30      ***Engineering Design*** – T. Nicol
- LMQX cold mass assemblies
  - Vacuum Vessel (*features, size, constraints, access*)
  - Beam Tube
  - Heat Loads and Cooling
  - 1.9 K Heat Exchanger
  - Buswork passing between and through the magnets
  - Phase Separator
  - TAS2 and TAS3 (*radiation, heating/cooling, supports*)
- 10:45      ***Break***
- 11:00      ***Interfaces*** –
- MQXA and MQXB
  - Corrector Magnets
  - DFBX
  - LQX to LQX (*Q3-Q2, Q2-Q1*)
  - Tunnel installation and Alignment
  - Cold Bore
  - BPM
- 12:30      ***Lunch***
- 14:00      ***Interfaces*** –
- Drawings (*in preparation, complete, in CDD*)
  - Shipping
  - Safety (*FNAL Engineering Safety Notes, Safety Review Documentation*)

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**EDR Agenda – LQX Cryoassemblies**  
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15:00	<i>Discussion of Reviewer Comments</i> – P. Pfund
16:00	<i>Break</i>
16:30	<i>Discussion of Reviewer Comments – continued</i>
17:15	<i>Conclusion</i> – J. Strait
17:30	<i>Adjourn</i>